Military green technology: present and future

Zoran M. Miličević[a] , *Zoran S.* Bojković[b]

[a] Serbian Armed Forces, General Staff, Telecommunications and Information Technology Directorate (J-6), Belgrade, Republic of Serbia,
e-mail: zoran.milicevic@vs.rs, **corresponding author**,
ORCID iD: https://orcid.org/0000-0003-3512-4188

[b] University of Belgrade, Belgrade, Republic of Serbia,
e-mail: z.bojkovic@yahoo.com,
ORCID iD: https://orcid.org/0000-0003-1323-0115

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Abstract:

Introduction/purpose: This paper aims to present military green technology through present concepts, solutions and challenges, as well as through future trends, particularly in wireless communication.

Methods: Analyses and syntheses were used to consider various aspects, challenges and developments of military green technology.

Results: Important aspects of organization, challenges and strategies in military green technologies are presented. Next, the role of a green energy action plan is emphasized. Furthermore, green defence solutions and security challenges are considered. Besides presenting green technologies of today, primarily focused on wireless networks, especially 5G, the paper also considers the impact of biofuels, methanol-based fuel cells, hydrogen fuel cells, hybrid electrical vehicles and photovoltaic energy. Finally, green technologies for the future are presented through some of the most important technologies: next generation wireless networks, pulse detonation engines, piezoelectricity, and biodegradable platforms.

Conclusion: Military green technology is now necessary for approaching wireless networking in order to meet challenges of high demands of wireless traffic and energy consumption. Also, military green technology will require further constant considerations in the field of efficiency and sustainability of application as well as research to provide different acceptable solutions, not only in technical, but also in the organizational domain, in order to be applied in military environment.

Key words: wireless networks, methanol-based fuel cells, hydrogen fuel cells, photovoltaic energy, pulse detonation engines, biodegradable platform.

Introduction

Military green technology evolution has a large impact not only on the development of active research in wireless communications, but also on industry applications. Some examples are network technologies and energy efficiency algorithms as well as protocols, service quality provisioning, etc. All these issues require interdisciplinary fields such as various networks, power systems, and devices. In wireless systems i.e. mobile users or service providers, energy efficiency (EE) and networking are of huge importance. A range of main wireless technologies are part of new networks such as device-to-device communication, spectrum sharing, Internet of things, ultra-dense networks, etc. As for military green technology, the main characteristics consist of offering a system solving the following operational challenges:

- High impact deployment cost,
- High expenses involved in buying, installing and maintenance,
- Reducing toxic emissions, and
- Low power generation rates compared to fuel.

Military green communication systems are designed to be focused on increasing spectrum efficiency (SE). In order to compare SE transmission, technologies such as orthogonal–frequency division multiplexing (OFDM), multiple-input multiple-output (MIMO) as well as non-orthogonal multiple–access (NOMA) are used.

For military organizations, it is necessary to take into account the development of green network solutions and to implement them. It means that it will be of importance to explain how different solutions are in accordance with military operations in order to improve capability. There are many examples showing how characteristics such as interests of organization, technological innovations as well as political reasons influence the development and implementation of green network technology and policy. This offers many possibilities and motivation that are necessary from the point of view of political and military personnel responsible for decision making.

Organization, challenges and strategies in military green technologies

Starting from the early 1950s, armament and military equipment have grown exponentially in quantity, becoming more sophisticated and more costly to operate. Demands on power consumption for military

needs have increased because military equipment today consists of multiple communication radios and corresponding components connected to various conditioning systems. Higher energy consumption results in increased operating costs as well as support costs. Exposed energy supply lines and fuel convoys were demonstrated to be easy targets for enemy attacks.

The content and formats of green strategies show how different political, military, technological and organizational aspects affect the development of such strategies. While strategies developed by some world countries concentrate on a limited number of operational challenges and requirements, there are more general strategies which encompass different goals, tasks, organizations as well as legacy equipment. These differences mean that world countries must define their own green strategies. Green strategies should be connected vertically through different government agencies from higher levels. State agencies, ministries of defence and military services above all, should develop green strategies that are connected with green strategies of high level state authorities.

A lot of different countries have been dealing with and developing green strategies in recent years and, as a result, defence should be clearly included in them. This was a solid base for the beginning of the development and implementation of new green strategies and technologies. With the deployment of Fourth Generation (4G) systems all over the world, energy consumption is growing daily, increasing ecological impacts, likelihood of bigger climate change, health concerns for the user, etc. In this context, Fifth Generation (5G) systems are viewed as the key network technology that will meet the challenge and allow the realization of a highly-connected society where billions of users, via their respective devices (wearables, smart phones, connected cars, laptops, etc.) and machines such as IoT devices, drones, etc. will be able to exchange data and other services at higher QoS levels. The fact that 5G architecture focuses on developing new green technology, cell deployment strategies and resource allocation in order to improve energy efficiency makes people more motivated to acknowledge its recent results worldwide.

In order to improve EE, 5G architecture focuses on developing new greener technology. Increasing SE is one of the most important ideas in green communication systems design. Military green energy services vary in capacity and are highly dependent on the location and the weather which make it a key challenging task in the deployment and management of wireless communication networks. The fundamental

design criterion in developing military green wireless communication networks would be shifted from energy efficiency to energy consumption and sustainability due to the nature of green technology. As for green networking, it helps to define the overall research climate.

Green Action Plan

With the Green Action Plan (2021-2025), military defence systems of each country have to trace a leading role in the green transition towards a sustainable future, a more climate-friendly approach and a greater responsibility for climate technology development (Danish Ministry of Defence, 2021). The Action Plan has to be uploaded and adjusted annually as new and better ways are being invented to fulfill green ambitions. Green transition must not compromise the ability to conduct operations. It should support and not block it. Therefore, the Action Plan does not outline any goals that could compromise operational effectiveness. It is possible to apply initiatives that will have the greatest possible effect on green transition in the areas such as nature, use of energy, air pollution, soil and groundwater, sewage and surface water, resource production, noise and vibrations.

Green defence

Green defence deals with the development and implementation of ecological processes which are undertaken by military in order to increase energy efficiency and mitigate negative influence on the environment without negatively influencing operability. A survey of the countries interested in green defence measures reveals that the issue of energy efficiency exists at several levels, such as: economic, operational and strategic. As a logistical effect on operating equipment, operating costs have consistently grown for platforms across the world (Burg & Scharre, 2015).

The risk of attacks on fuel convoys has forced armed forces to provide alternative sources for supply routes and thus mitigate risks for personnel. Also, when electricity grids are vulnerable to terror attacks and different catastrophies, alternative energy sources are in a position to mitigate the rise of going off the grid. From a strategic point of view, reliance on oil and gas leads to the autonomy of a state. As climate changes exist, public perception acts as a strong force to support engagement in military environment.

The green defence concept, together with the four main security challenges, is shown in Figure 1.

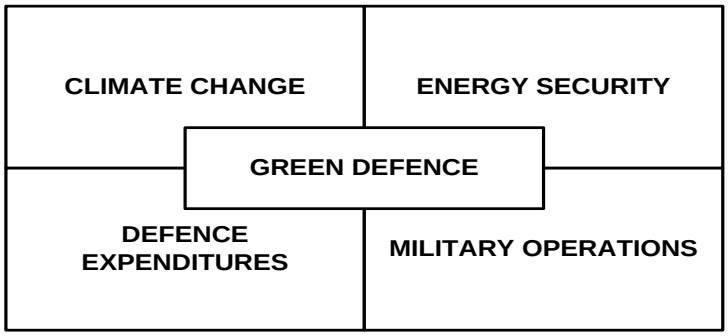

Figure 1 – Green defence concept and security challenges
Рис. 1 – Концепция «зеленой обороны» и проблемы безопасности
Слика 1 – Концепт зелене одбране и безбедносни изазови

These are: climate change, energy security, military operations and defence expenditures. As for green defence, it includes different actions and domains such as: operations, logistics, engineering and defence planning. Energy resources are the most important for national security while a continuous supply of such resources always has been a key priority.

Green defence solutions

In order to identify relevant and important items to make difference between security challenges, it will be of fundamental importance to separate how a solution is connected to a given challenge. Different solutions are significant for dealing with efficiency and effectiveness. Green defence is relevant at many different levels, but also difficult to operationalize and access. Characteristic examples of green defence solutions are distributed into two groups: green technologies and green strategies. They both demonstrate the way how green solutions are developed and after that invoked to be adapted not only to military organization, but also to technological needs. Many countries developed green strategies connected to environmental and climate challenges. Green strategies appropriate for defence offer something new. However, many countries are paving the way to developing appropriate green strategies for their armed forces. Energy efficiency serves as a unique force multiplier, increasing much more the range of endurance of forces

in the field while evidently reducing the number of combat forces protecting energy supply and at the same time reducing long-term energy costs. Green solutions and general security can be connected, presenting at the same time a huge interest for common green public policy challenges. A network-zero military installation is about to address the security challenges of three main topics: climate change, energy security and optional fuel consumption. Also, in that way a network-zero installation could be an appropriate solution to all challenges, involving greenhouse gas elimination, reducing the need for supply with foreign fuel and finally improving operational fuel efficiency. It can be analytically difficult to describe the link between green military solutions and various security challenges. An analytical challenge is important to emphasize and should be addressed in future green policy initiatives. The relevance, impact and cost-effectiveness of different solutions are difficult to access as the links between solutions and challenges are not analyzed and described comprehensively. The link can be described either qualitatively or quantitatively, or both, but should be addressed clearly. This is particularly important in the development and selection of green solutions since many security challenges will be of cross-cutting nature involving multiple areas, organizations and policies. It is of special interest to the users that green military technologies and strategies can address multiple security challenges simultaneously.

Green defence and security challenges

It is well known that the number of green technologies that potentially could be used by military organizations is of huge significance. This is the main reason why it is necessary to provide developing a more compenhensive mapping of available technologies. Next, it is recommended to analyze and describe how a green solution is limited to a security challenge before deciding on a specific set of green solutions. Finally, through developing green strategies, it is necessary to know how green technologies and strategies are coordinated. The connections between green defence solutions and security challenges are straightforward, when describing them explicitly. In that way, in order to compare the described solutions, policy makers are enabled to select at the same time efficient and effective solutions aimed at the most significant challenges. Table 1 connects the green defence concept which consists of four security challenges: military operations, defence expenditure, energy security and climate changes. In order for a green solution to work, it will be of importance to change behavior along with the introduction of new green technology. However, changing

organizational and individual behavior is a challenge: not just in military organizations, but in organizations in general. Organizations and individuals are said to resist change due to inertia, costs, resources, and threats to the power base, values and benefits and mobility to perceive alternatives.

It is important to address these challenges by providing specific green solutions, i.e. by understanding how a number of aspects such as organizational interests, technological developments, and political goals influence the development and use of green technologies and strategies. This creates a number of possibilities and challenges that need to be taken into consideration primarily by military decision makers.

Table 1 – Green defence concept with security challenges and general and specific solutions

Таблица 1 – Концепция «зеленой обороны», проблемы безопасности, общие и специфические решения

Табела 1 – Концепт зелене одбране са безбедносним изазовима, општим и специфичним решењима

Concept	Security challenges	General solutions	Specific solutions
Green defence	Military organization Defence expenditure Energy security Climate changes	Reduced energy demand Inverse and diversity energy supply Adjust force structure and defence planning	New green technologies - More efficient combustion engines - Solar panels Green strategies and management systems - Green strategy for defence - Key Performance Parameters

The concept of green defence shows promise with regard to energy security. Diversification in energy sources and reduced consumption of energy will be significant elements in addressing a policy response to future energy challenges. This fact indicates that military forces will be more resilient in the case when they have developed and implemented variable green solutions.

Green technology for today

Green communications are one of the major attributes of 5G systems. Unlike traditional energy services, green energy services vary in capacity and are highly dependent on the location and the weather which makes it a key challenging task in the deployment and management of wireless communication networks. The fundamental design criterion in developing green wireless communication networks would be shifted from energy efficiency to energy consumption and sustainability due to the nature of green technology. Green communication systems design is focused on increasing spectrum efficiency (SE). Green networking not only led to significant results in the past (orthogonal-frequency division multiplexing OFDM, multiple-input multiple-output MIMO, non-orthogonal multiple access NOMA), but also helped defining the overall research climate. The increase in power consumption and carbon footprint of cellular networks has led to various proposals for green mobile networks solutions from telecom providers, governments and researchers. Different types of electrical military vehicles are joining power grids including renewable resources, energy storage, etc. These elements are distributed at different levels and areas of power grids and have influence on huge-scale energy management in practice. To meet the challenges raised by high demands of wireless traffic and energy consumption, green evolution has become a need for today wireless networks; as energy saving and environmental prediction become not only necessary demands, but also trends, researchers and engineers have moved their interest to energy efficient-oriented design, green radio (GR). This was a research direction for the evolution of future military wireless devices and architectures, toward high energy efficiency (EE). The most common approach is to define it as the ratio between the military system throughput and the power consumption. As for GR, it has targeted solutions based on joint energy and communication cooperation. Energy compaction is a cost saving approach on the supply side. At first, the major application scenarios for 5G mobile networks bring the characteristics which include that scenarios such as enhanced mobile broadband (eMBB) ultra-reliable and low-latency communication (uRLLC), and massive machine type communication (mMTC) have to be taken into account. Secondly, mobile terminals have to be supported together with energy efficient solutions. Also, network nodes such as MIMO and ultra-dense networks (UDNs) introduce new design challenges when speaking about EE military schemes. In this environment, the green radio plays a significant role in green wireless

system design. There are several fundamental frameworks for military GR research such as: deployment efficiency – energy efficiency, spectrum efficiency – energy efficiency, bandwidth-power trade off and delay-power trade off. In the last decade, the research activity has moved to the EE study of military access radio network (RAN) side (Miao et al, 2010, pp.545-554). The goal was to jointly reduce the power consumption and improve spectral efficiency (SE) at the same time, in order to maximize the EE of wireless networks. If military circuit power consumption is considered, SE and EE cannot be improved simultaneously.

While their operational advantages are important for determining what future green militaries will look like, their few technology levels provide minimal information on their cost-effectiveness.

Biofuels

Biofuels are one kind of fuels which originate from organic matters. They are receiving significant attention for their characteristic to replace petroleum–derived fuels. Different forms of particulate organic matters are used for biofuels in defence applications, especially to meet specific supersonic flight requirements.

For lower carbon emission, it is possible for synthetic kerosene to be blended with petroleum fuels (Lamprecht, 2007, pp.1448-1453). It should be noted that synthetic fuels are expensive to produce as well as maintain. Also, synthetic fuels are time-consuming to produce in large quantities, which is a limiting factor. Next, application of synthetic fuels in armed forces is much more limited than that of other types of biomass alternatives. On the other hand, next generation biofuels are accepted as the most promising ones for their high efficiency levels – but they are not a viable final solution. Further research and development is needed to modify the composition of biomasses to make them more efficient and cleaner.

Fuel cells based on methanol

Special kinds of fuel cells which convert "energy of chemical reactions into electrical energy without combustion with virtually any pollution" are used to generate as well as store energy (Crull, 2006). The important advantages of methanol-based fuel cells are as follows: adaptability with other equipment, ability of direct and reformed methanol-based fuel cells to blend with gasoline, combat kits weight reduction up to 80%, increased mobility of military forces based on a power supply solution, applicability in a range of electrical and electronic

devices as well as different platforms with UAVs and submarine propulsion systems, low accoustic, vision and thermal systems. On the other hand, the most important disadvantages are: increasing prices and higher toxicity as well as lower density than other alternative fuels such as ethanol.

Hydrogen fuel cells

Hydrogen energy is another alternative source that armed forces have considered for cutting electrical energy costs and for reducing carbon emission. Similarly to methanol–based fuel cells, it is an alternative for military uses. The density of hydrogen makes it more usable in comparison to other types of fuel cells. Hydrogen as an energy carrier is expensive to generate, store as well as transport. Production of hydrogen energy requires more fossil fuels. The need to use fossil fuels for hydrogen energy production seriously puts into question its status as an alternative energy source. Nevertheless, armed forces' interest in it continues for almost two decades.

Hybrid electrical vehicle

Hydrogen fuel cells tehnology improvement offers hybrid electric drive (HED) for vehicles that include battery–powered engines together with case gasoline engines to charge battery. Compared to standard two speed gas engines, the advantage of HED vehicles is that they use less electrical energy when operating at low speeds. Today, the fact is that vehicles powered by single engines are recognized to be more efficient than HED vehicles. However, armed forces have acceptable experience with HED, especilally when largely depending on three important categories: domain, speed and acceleration. It should be noted that efficiency gains are twice as high for HED not only on the land, but in aerial domains, as well.

Photovoltaic energy

Today, photovoltaic energy represents solar fuel cells suitable for armed forces and aiming at primarily reducing energy consumption. The advantages of photovoltaic energy are: reduced power demand in basic areas, proven appropriateness for unmanned vehicles, up to 90% in fuel use reduction, and market forces significantly cutting costs. On the other hand, the disadvantage of photovoltaic energy is minimal mission flexibility dependant on weather influences, especially cloudiness, while the space–based solar alternative is not suitable because it is expensive. Also, results achieved in desert conditions can be beneficial but are not

generally applicable in all types of the environment. It should be added that photovoltaic security risks jeopardize military frequencies communications and surveillance technologies.

Green technology for the future

In the last years, the research activity has moved to the energy efficiency (EE) study of the radio access network (RAN) side. The goal was to jointly reduce power consumption and improve spectral efficiency (SE) at the same time, in order to maximize the EE of wireless networks. If circuit power consumption is considered, SE and EE cannot be improved simultaneously. In order to improve the bandwidth efficiency, the Shannon channel capacity theory is often implemented to develop signal-input signal–output (SISO) systems together with multiple antenna MIMO systems. From Shannon's mathematical theory of communication (Shannon, 1948, pp.623-656), the maximum achievable rate of transmission, i.e. the capacity C of a channel of the band W, scales logarithmically with the received signal–to–noise ratio (S/N), i.e. $C=W\log(1+S/N)$.

Taking into account that a sustainable future wireless network must be not only spectrum efficient, EE and SE become an important step in 5G research. Cellular systems have many opportunities to become greener from the equipment point of view, for example through operating in line with traffic version in time and space. When the total power is considered, there is a green point on the EE – SE curve where the maximum energy efficiency is achieved. When the circuit power is considered, there is a green point on the EE- SE curve where the maximum energy efficiency can be considered; there is also a green point on the EE – SE curve where the maximum energy efficiency can be achieved. For example, EE and SE improvement of 5G and 4G is achieved owing to the introduction of more antennas. If more antennas are introduced in order to increase both EE and SE, the total power consumption will increase, too. On the other hand, the increase of total power cannot be well controlled. The fact that 5G is capable of supporting versions of wireless services in diverse scenarios and could offer universal connectivity for individual consumers as well as vertical industries opens the door to huge opportunities for a greener society and life style. 5G could help to reduce traffic congestion in urban areas via intelligent vehicle scheduling. This leads to significant energy saving.

Three technologies most important for tomorrow are: pulse detonation engines, piezoelectricity and biodegradable platforms.

Pulse detonation engines

In order to produce thrust, pulse detonation engines use near–constant volume combustion and constant pressure. Besides being able to compress quickly and add heat constantly, pulse detonation engines can achieve a higher thermodynamic efficiency as well as replace moving parts in engines which are in operation today. Investigations in the area of pulse detonation engines currently focus on involving turbojets and cruise missile systems together with UAV applications (Bojkovic et al, 2020, pp.3-29; Johnson, 2010).

Piezoelectric effect

Piezoelectricity is the process of generating electricity from motion. Today, in the military domain, it is very important to solve how to obtain electric energy from mechanical energy generated by different war platforms, for example warfighters and land vehicles (Dillow, 2009). In the future, piezoelectricity can be used to power electrical devices and provide operational advantages similar to those of methanol-based fuel cells.

Biodegradable platform

The Defence Advanced Research Projects Agency (DARPA) is researching biodegradable platforms with a focus on synthetic biology. DARPA's Inbound, Controlled, Air – Releasable, Unrecoverable Systems (ICARUS) program was started in 2015 (DARPA, 2015). One example of biodegradable platforms presents how such material would be used in aerial delivery vehicles that, having completed their tasks, disappear into thin air without polluting the environment and without having to return to their original launch sites (DARPA, 2017). Similar to other futuristic technologies, there are few signals about the eventual cost–effectiveness of such materials based on the early research and technology stages.

Conclusion

Military green technology is now a needed wireless networking approach to meet challenges posed by high demands of wireless traffic and energy consumption. Green communications represent a trend in the academic and industrial networking and an important research path for developing future mobile architecture and for innovations to achieve high EE. Also, it is highly possible that SE performance will increase in future 6G communications, which means that military green energy efficiency will be further enhanced with boosted power consumption. When

wireless military communication industry follows this trend, the associated carbon emissions will increase to an acceptable level. That is the main reason why it is important for the industry to break the energy–efficiency trade–off and improve energy-efficiency performance while maintaining high spectrum efficiency.

Green solutions have previously been connected, particularly in U.S., in order to bring military operational effectiveness. Large amounts of fuel are necessary to operate advanced military technologies. The framework combines the operational challenges together with security challenges, such as defence expenditures, energy security, and global climate change. There are many specific green military initiatives to describe the way how green technologies can be implemented, while at the same time how behavioral change can be achieved. A particular focus is on how green strategies have been formulated in order to recognize objectives, challenges and green solutions and how important elements are connected in strategies. The structure of green technology and green strategies reflects considerable potential of green solutions. They show military potentials, possibilities and challenges related to the use of green technologies and strategies. It is also visible that the interest in reducing costs of green defence stems from a desire to mitigate operational risks, such as attacks on fuel convoys, which sometimes increase energy independence. Green technologies can affect the operational and organizational elements of forces of the future. The operational advantages offered by green technologies can be summarized in categories that will help to define the future battlefield. First are portable technologies on soldiers including wearable solar cells and methanol fuel cells to reduce the weight and increase the power duration of equipment used in military missions. Next is the ability to generate, distribute and store power more efficiency and with signatures, as it is relevant for forward operating bases. Similarly to portable technologies, distributed power allows disaggregated units to operate for longer in the field. Lastly, alternative energy sources could become a force multiplier for unmanned systems with some prospective green technologies offering almost all extending flight times.

Smaller platforms with more dual–use components, including unmanned vehicles, are available under the condition to be used by a great number of users. With distributed power systems, it can be difficult for fighters or terrorists to target centralized systems which have impact on wider forces or population. Further, green technology has the tendency to treat alternative energy sources as valuable substitute goods which can be used for a system as one–to–one replacement for fossil

fuels. Unfortunately, the comparison of biofuel to petroleum prices fails to take into account the cost of different equipment such as batteries and rechargeable systems that fuel cells could render redundant. When prevously applied to the military area, the operational advantages should be visible even in situations when fuel cells are unexpectedly more expensive than batteries and chargers. Economic perpectives on green defence technologies are promising for smaller armed forces such as militaries which can use the benefits of commercial technologies when prices are driven down. For example, increased demand for solar systems has made more producers be interested in supplying them to the market and this development in turn has forced prices down. Given technologies look suitable for operational and environmental considerations. They can find appropriateness in armed forces of different sizes.

Nowadays, military green technology represents one of important technologies for armed forces (including the Serbian armed forces) through research and implementation of different kinds of solutions. Also, it has a significant role in future action plans in order to achieve a higher degree of energy efficiency and to be suitable for implementation in a variety of different equipement applied on the battlefield with acceptable cost of operation.

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Военные зеленые технологии: настоящее и будущее

Зоран М. Миличевич[а], *Зоран С.* Бойкович[б]

[а] Вооруженные силы Республики Сербия, Генеральный штаб, Управление телекоммуникаций и информационных технологий (J-6), г. Белград, Республика Сербия, **корреспондент**

[б] Белградский университет, Белград, Республика Сербия

РУБРИКА ГРНТИ: 49.33.29 Сети связи
ВИД СТАТЬИ: обзорная статья

Резюме:

Введение/цель: В данной статье представлена концепция военной зеленой технологии с акцентом на существующие вызовы, задачи и решения, а также на тенденции в будущем. Особое внимание уделяется военной зеленой технологии в области беспроводной связи.

Методы: При рассмотрении различных аспектов, проблем и разработок военных зеленых технологий использовались анализ и синтез.

Результаты: В статье представлены важные аспекты организации, проблемы и стратегии военных зеленых технологий. Также подчеркивается роль плана действий по возобновляемой

энергии. Помимо того, рассматриваются вопросы обороны с экологической точки зрения, а также вызовы в области безопасности. В том числе описано состояние зеленых технологий на сегодняшний день, которые в первую очередь ориентированы на беспроводные сети, особенно 5G, а также воздействие биотоплива, метанольных и водородных топливных элементов, гибридных электромобилей и фотоэлектрической энергии. В заключении представлена взаимосвязь зеленых технологий будущего с наиболее важными технологиями, такими как: беспроводные сети следующего поколения, импульсные детонационные двигатели, пьезоэлектричество и биоразлагаемая платформа.

Выводы: Военные зеленые технологии в настоящее время являются главным фактором в решении проблем, связанных с высокими требованиями к беспроводным сетям, трафику и энергопотреблению. Однако военная зеленая технология требует постоянного изучения вопроса эффективности и устойчивости применения, а также поиска различных приемлемых решений не только в техническом, но и в организационном плане в целях успешного применения в военной среде.

Ключевые слова: беспроводные сети, метанольные и водородные топливные элементы, фотоэлектрическая энергия, импульсные детонационные двигатели, биоразлагаемая платформа.

Војна зелена технологија: садашњост и будућност

Зоран М. Миличевић[а], *Зоран С.* Бојковић[б]

[а] Војска Србије, Генералштаб, Управа за телекомуникације и информатику (J-6), Београд, Република Србија, **аутор за преписку**

[б] Универзитет у Београду, Београд, Република Србија

ОБЛАСТ: телекомуникације
КАТЕГОРИЈА (ТИП) ЧЛАНКА: прегледни рад

Сажетак:

Увод/циљ: Овај рад настоји да прикаже војну зелену технологију кроз садашње концепте, решења и изазове, као и кроз будуће трендове, посебно у бежичној комуникацији.

Методе: Анализе и синтезе су коришћене за разматрање различитих аспеката, изазова и развоја војне зелене технологије.

Резултати: Приказани су важни аспекти организације, изазови и стратегије у војним зеленим технологијама, а наглашена је и улога зеленог акционог плана за енергију. С друге стране, разматрају се зелена одбрамбена решења и безбедносни изазови.

Такође, у раду су представљене данашње зелене технологије које су првенствено усмерене на бежичне мреже, посебно 5Г. Сагледан је и утицај биогорива, горивих ћелија на бази метанола, водоничних горивних ћелија, хибридног електричног возила и фотонапонске енергије. Зелене технологије будућности представљене су кроз неке од најважнијих технологија: бежичне мреже следеће генерације, импулсне детонационе машине, пиезоелектричност и биоразградиву платформу.

Закључак: Војна зелена технологија данас представља неопходан приступ бежичном умрежавању како би се одговорило на изазове високих захтева бежичног саобраћаја и потрошње енергије. Такође, војна зелена технологија захтеваће и стална разматрања у области ефикасности и одрживости примене, као и истраживање и проналажење различитих прихватљивих решења, не само у техничком, већ и у организационом домену, како би се применила у војном окружењу.

Кључне речи: бежичне мреже, горивне ћелије на бази метанола, водоничне горивне ћелије, фотонапонска енергија, импулсни детонациони мотори, биоразградива платформа.

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